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The Asymmetry of Galaxies: Physical Morphology for Nearby and High Redshift Galaxies

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abstract

We present a detailed study of rotational asymmetry in galaxies for both morphological and physical diagnostic purposes. An unambiguous method for computing asymmetry is developed, robust for both distant and nearby galaxies. By degrading real galaxy images, we test the reliability of this asymmetry measure over a range of observational conditions, e.g. spatial resolution and signal-to-noise (S/N). Compared to previous methods, this new algorithm avoids the ambiguity associated with choosing a center by using a minimization method, and successfully corrects for variations in S/N. There is, however, a strong relationship between the rotational asymmetry and physical resolution (distance at fixed spatial resolution); objects become more symmetric when less well-resolved.

We further investigate asymmetry as a function of galactic radius and rotation. We find the asymmetry index has a strong radial dependence that differs vastly between Hubble types. As a result, *a meaningful asymmetry index must be specified within a well-defined radius representative of the physical galaxy scale.* We enumerate several viable alternatives, which excludes the use of isophotes. Asymmetry as a function of angle (A_ϕ) is also a useful indicator of ellipticity and higher-order azimuthal structure. In general, we show the power of asymmetry as a morphological parameter lies in the strong correlation with $(B - V)$ color for galaxies undergoing normal star formation, spanning all Hubble types from ellipticals to irregular galaxies. Interacting galaxies do not fall on this asymmetry-color "fiducial sequence," as these galaxies are too asymmetric for their color. We propose to use this fact to distinguish between 'normal' galaxies and galaxies undergoing an interaction or merger at high redshift.